

## CHAPTER VII.

### THE COAL BEDS.

Important as coal is in its relations to the industrial prosperity of a community, and as extensively as mining is carried on in some localities, the proportion which the seam bears to the entire thickness and mass of Carboniferous strata is surprisingly small. On the whole the coal layers probably do not compose more than one-sixtieth of the entire thickness of the productive measures and in the majority of cases one one-hundredth, would be nearer the actual ratio. In thickness Iowa veins vary from a small fraction of an inch, a mere film, to ten or twelve feet; and at least one place is known where the vertical measurement is fully fifteen feet. The number of seams in different localities is not the same; in some places only one bed being present, in others upwards of a dozen.

*Extent of Individual Coal Beds.*—The geographical extent of single coal strata has long been the subject of much discussion, both at home and abroad. In the Appalachian region individual veins, like the Pittsburg seam, are recognizable over large stretches of territory. But in Iowa there is no such wide reaching continuity of coal layers. The workable beds, though numerous are more or less distinctly lenticular and are more limited geographically than in the eastern field. The arrangement in the western area of the bituminous deposits in numberless

basins, at many different horizons in the Carboniferous series, is such as to give to each county a very much larger amount of coal than could possibly be disposed in one or two continuous sheets of the thickness of any one of the basins, and spread out over the whole district equally.

The great similarity of the different coal seams and their associated beds enables almost identical vertical sections to be seen in widely different localities and at very different horizons. Hence, unless extreme care is taken, and a given layer traced from point to point, great confusion is apt to occur in regard to correct identifications. This similarity of carbonaceous beds has given rise to the opinion that coal layers in general are very persistent, extending continuously over broad stretches of country. Among the extremists defending this theory may be mentioned Lesquereux, who states\* in summing up his conclusions in regard to the fossil plants of Illinois:

“I think we can readily admit that the contemporaneousness of formation is recognizable over the whole extent of our coal fields, not only on a general point of view but even considering each separate bed of coal.” This assertion was not made concerning the Pennsylvanian coal seams alone but was applied to beds which were thought to spread out continuously from the Appalachian coal fields as far as the Mississippi river or even into regions still farther west.

Newberry† has shown conclusively that the writer just mentioned was in error in regard to the coal beds, at least so far as Ohio is concerned. It is also now generally conceded that in Indiana and Illinois the individual coal beds

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\* Geol. Sur. Illinois, vol. II, p. 467. 1866.

† Geol. Sur. Ohio, vol. II, pp. 166-167. 1874.

do not have near the extent that they were once supposed to possess. The same has been more recently found true of both the Iowa and Missouri areas.

*Character and Number of the Coal Beds.*—There is an opinion among the miners of the state that there are three workable coal veins. These are usually designated as the "first," "second" and "third" seams. Should subordinate beds be encountered in the sinking of a shaft they are not taken into consideration. As a matter of fact the occurrence of several seams in a locality is purely accidental. The "three" veins are not continuous over areas of any great extent, and may have widely different stratigraphical values, even within very short distances. The "first," "second," and "third," seams of one shaft may be entirely distinct from the similarly called beds of another mine but a short distance away. A noteworthy instance for citation in this connection is a boring made near the city of Des Moines. It was two hundred feet in depth. Twelve distinct coal horizons were passed through, giving a total thickness of coal of thirteen and one-half feet; yet none of the beds were thick enough for profitable working. Only one-third of a mile away was a mine removing coal from two seams, one of which was four to five feet thick. It thus happens that in counties where the Coal Measures are 200 or 300 feet in thickness below the "third" vein, and could be easily penetrated with every probability of reaching workable beds, it is impossible to induce operators to search for coal below the lowest of the three beds known, and as soon as the coal has been recovered from the three veins the mines are abandoned. Yet, on the other hand, so widely spread are the ideas of the great extent of workable coal veins that it is not unusual to find persons engaged in mining, claiming to be

operating the identical beds which are worked in distant parts of the state. Some operators in Dallas county, and even Guthrie county, have expressed great confidence in finding the "Des Moines vein" in all its thickness and properties by boring deeper than the shafts at present operated. The "first," "second," and "third" veins are sometimes thought to extend over nearly the entire state. This conception is often firmly believed to be the exact arrangement of the coal beds. In the western part of Keokuk county, where the Coal Measures are quite thin, and where only one seam of coal has been opened, borings for the "second" vein were commenced not long ago in a knoll of Saint Louis limestone and put down more than 200 feet. This is only an isolated case taken from many which shows the fallacy regarding the wide areal distribution of single seams.

The stratigraphical importance of the coal seams is not so great as has generally been supposed, since as already shown, the bituminous beds are, with very few exceptions, quite limited. Few cases are at present known in which the geographical extent of a workable coal stratum is more than four or five miles. It follows that the coal seams of this region are not nearly so extensive as commonly regarded and that until the more important coal horizons are carefully made out they possess little value in general correlations.

The basal coal seams in the Lower Coal Measures of Iowa appear to be much more extensive than those toward the top, where they may be only a few inches in vertical measurement and perhaps a few hundred yards in extent. The coal may, therefore, be considered, as stated already, as disposed in numerous basins of greater or less area, thickened centrally, but gradually becoming attenuated

toward the margins. This arrangement is seen in the Des Moines river section of the Lower Coal Measures. (Plate xiv.) It may be more clearly represented by the following (figure 15).

The disposition of the coal in numerous limited lenticular basins instead of a few layers extending over broad areas is of the utmost importance from a purely economic standpoint. In all mining operations and in all prospecting it is very essential that this fact be kept constantly in mind. With methods of boring more modern than those commonly employed throughout the western states, there is every reason to believe that, in the Lower Coal Measures especially, the large majority of good coal

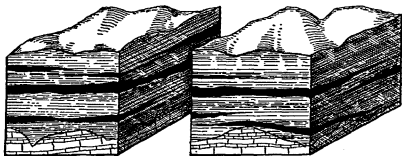


Figure 15. Stratigraphical Arrangement of Iowa Coal Beds.

seams twelve inches in thickness and over, encountered in prospecting, can be traced readily and easily to localities where they are thick enough for profitable working.

#### INTERRUPTED CONTINUITY OF THE COAL BEDS.

In Iowa the restrictions upon the distribution of the individual seams are not numerous as compared with other regions. Yet there are disturbances of various kinds which break the continuity of the coal strata, locally interfering somewhat but seldom severely with mining operations. They are referable to the three general agencies of deposition, erosion and dislocation.

*Irregularities of Deposition.*—These are due (1) to unequal subsidence or elevation; (2) to the unevenness of the Coal Measure floor; (3) to the former presence of varying currents. The effect of greater movements, upwards or downwards, in one part of an area than in another is to cause various beds to thin out in some directions or to increase in thickness in others. Old currents are directed out of their original courses or they bring in a different class of sediments.

The unevenness of the floor upon which the coal is deposited is due to a number of different causes. Before deposition there may have been gentle folds or undulations in the strata beneath whereby the coal was allowed

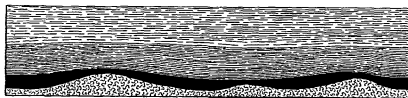


Figure 16. Uneven Character of Surface upon which Coal was Deposited. Markham Mine, Marion County.

to accumulate in synclinal troughs of the subjacent limestones. These folds, however, are commonly so broad that they affect but little single coal basins. Usually they limit the seam on one side, but unless the basin be very large there is little interference in the interior. Another cause for the unevenness of the coal seam is the undulatory character of the original swamp bottom. (Figure 16.) The same effect is produced also by the unequal density of the strata beneath the coal. When the pressure increases over the more open textured portions of the beds, the coal strata above form small anticlines and synclines. Or, when a part of the underlying strata is very hard and

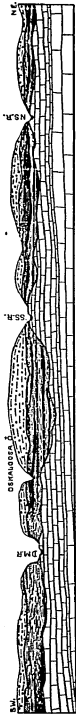


Figure 17. Ideal section across Mahaska County, showing unevenness of Coal Measure floor.

unyielding, as when sandstone is formed, the beds are unequally depressed.

Another cause for the unevenness in the coal seam is the presence of unconformities below. When the unconformity is wide spread and partakes of the character of an old eroded land surface upon which the coal deposits are laid down the unequal distribution of the layers is very noticeable. This is the case of the Coal Measures in Iowa. Where the Coal Measures are comparatively thin the recognition of the exact conditions is of the greatest import. The coal laid down in one of the old valleys is often of very limited extent, the separate seams terminating abruptly against old hillsides of the limestone. In some places several veins one above the other are known to end in the manner described. (Figure 17.)

There are minor unconformities in the Coal Measures themselves which though far less extensive produce the same results locally. The section at the Redrock quarry in Marion county already described may be taken as a good illustration.

On account of the inequalities of the bottom on which the coal rests the seam is apt to terminate abruptly; to gradually thin out or entirely disappear over a low elevation or swell; to subdivide in the basin into several minor areas. Or, the converse of these results is obtained in all

cases where depressions are present instead of elevations, causing local increases in the thickness of the coal.

Varying currents may also have influenced the accumulation of carbonaceous material, previous to or during the deposition of the coal. Currents of water may throw up small ridges which take the place of the coaly matter

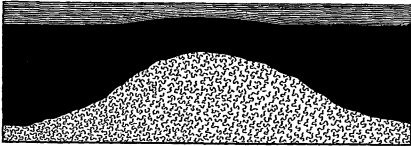


Figure 18. "Horseback" in Craig Slope. Kalo, Webster County.

so that locally the coal seam is very much thinner or often entirely pinched out over the elevations. (Figure 18.) The existence of former currents in an area where coal was formed may on the other hand cause an uncommon collection of bituminous material to take place. Thus

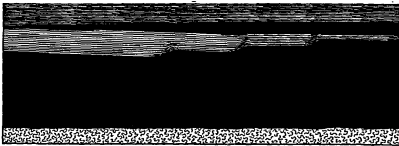


Figure 19. Extraneous Sediments in Coal Seam. Garfield Mine, Oskaloosa.

at some points an unusual thickness of coaly material will be laid down while in others it is almost entirely absent. Occasional currents may also bring in sediments during the deposition of the coal thereby dividing the vein in one or more parts. (Figure 19; also in figure 21).



Good examples of this are seen in the seams just north of the milldam at Des Moines and in the Garfield mine at Beacon, in Mahaska county.

. *Erosion.*—The effects of the corradng action of water are to cut out the coal seams partially or entirely in some places, and to destroy or weaken the roof in others. Of all the "troubles" encountered in mining in Iowa those rising from erosion are the most serious. The old erosive troughs are caused by the same action which is now in process at the surface through means of modern streams. The water courses constantly wear away the strata over which they run cutting out channels for themselves. As on the present surface, the size of the channel encountered is directly proportional to the volume and velocity of the stream and the length of time it has been at work and inversely proportional to the hardness of the strata. The excavations made through erosive action may vary greatly from the course of the smallest rill to valleys of almost any magnitude.

In point of time erosive channels may be divided into three classes: first, those which were formed during Carboniferous time, while the Coal Measures were yet being deposited; second, those which were made after the laying down of the Coal Measures previous to the glacial period; and third, those which have been formed since glacial times. The erosive effects of later geological or postglacial times are easily inferred from the present topography of the region. They cause but little embarrassment in mining operations for they are seen in the valleys of the modern water courses. The work of preglacial degradation cannot be read from existing surface relief. Consequently the old channels, now filled with sand and clay, are often unexpectedly encountered in

mining. As they abruptly cut out thick coal veins it is necessary before continuing the work of mining to prospect from the surface of the ground by means of boring in order to find out the extent of these "cutouts."

(1) Carboniferous Troughs. There is now abundant evidence to show that during the deposition of the coal bearing rocks of Iowa there were numerous minor periods of subsidence and elevation. During the latter the coal marshes were often above sea level and subjected to the action of running water. Coal beds which had been previously formed were often cut out in places by currents of water and subsequently filled with sand or clay which eventually became hardened into sandstone and shale. Carboniferous troughs of the kind described have been



Figure 20. Carboniferous Erosion : Sandstone Occupying "Cutout" in Coal Seam.  
Smoky Hollow Mine, Avery, Monroe County.

observed in a number of localities. In What Cheer mine No. 5, at What Cheer, in Keokuk county, and in the Smoky Hollow mine at Avery, in Monroe county, channels filled with sand have been encountered. (Figure 20.) In the first named mine the margin of the coal now lying next to the sandstone shows all evidence of weathering to the depth of several inches. At the second place the channel is more than 100 feet across and cuts out not only the coal but the underlying strata to a considerable depth. Carboniferous "cutouts" filled with shale have been noticed in the Dalby mine, at Angus, in Boone county, in the Smoky Hollow mine already mentioned, and the Frey mine at Confidence, in Wayne county, as well as elsewhere.

(2) *Preglacial Channels.* Probably no other class of "cutouts" interfere with mining to such an extent as those of this description. The material filling them being usually an incoherent sand or gravel through which water readily percolates and flows, forming underground streams. When suddenly broken into, a mine may be quickly flooded; or, if not, the entry must be walled up securely with solid masonry. At other times deposits of drift or plastic clay, boulders and logs of wood are encountered and if the entry be driven through, it must be well timbered or walled the entire distance by masonry. The preglacial channels are more apt to interfere with mining in those seams which are near the surface, while the deeper veins are rarely affected. Interferences of this character are found in almost every county of the state. At Fort Dodge several of the mines have been compelled to close on account of encountering channels filled with glacial débris. In the vicinity of Des Moines a number of preglacial "cutouts" are known. On the east side the "third" vein has been extensively mined. It lies from 90 to 125 feet below the surface. The roof is ordinarily very good, being composed of a thick black shale. The shafts first sunk in this neighborhood chanced to be on the west margin of an extensive coal basin. As the entries were driven eastward the coal became thicker which fact led to the sinking of other shafts in this direction. In six or eight of these the entries had been driven but a short distance when the roof caved in filling the mines completely with water and making it necessary to abandon them. It was found that running north and south through the middle of the coal basin was a broad valley filled with sand and gravel, along with logs of wood and other glacial material. Although the channel had not reached the coal bed it had cut almost

through the roof. When the coal was removed below the roof was unable to support the great weight of superincumbent water and gravel and so gave away. Since the mines were abandoned prospecting has been carried some distance to the eastward beyond the old channel which has been found to be nearly a mile wide. On its eastern border several shafts have recently been put down and are now working the coal in the opposite direction from this channel. In the consideration of the present position of the old stream it seems quite probable that this valley is a deserted channel of the Des Moines river which in later times has been directed along a new course

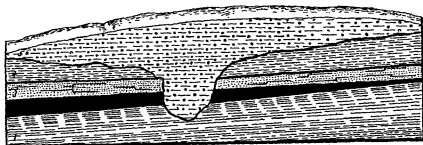


Figure 21. Preglacial Erosion: Drift Occupying Small Gorge. Old Polk County Mine, Des Moines.

a mile and a half to the westward. There is now a valley opening to the southward and connecting with the Raccoon river bottom which comes in from the west and forms part of the wide valley of the present Des Moines. At the north the valley mentioned unites with that of the Des Moines several miles above the Capital city. The fact also that the Des Moines river at the present time runs through a narrow gorge-like excavation seems to substantiate this view.

In south Des Moines narrow gorges filled with glacial débris have been met with in the Polk county mine when it was operating in one of the upper seams, and in several

other openings which were working near the surface. (Figure 21.) At the Runnells slope, sixteen miles south-east of Des Moines, a channel filled with boulders and drift has been traced for more than half a mile. Several branches open into it. At the Carbonado mine No. 4, south of Oskaloosa, in Mahaska county, a well marked channel of preglacial origin was recently encountered, and it has been traced a considerable distance. In that part of the mine where it first begins to be noticed it is found gradually cutting through the roof in a short V-shape runnel only five or six feet wide and about the

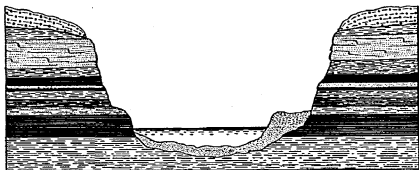


Figure 22. Postglacial Erosion: Gorge of Des Moines River at City of Des Moines.

same depth. In the course of a quarter of a mile it has a width of more than 150 feet cutting out all the coal and extending some distance below the seam. At Mystic, in Appanoose county, east of the Lodwick mine a channel over 1,200 feet in width has been found. Smaller and narrower channels are not infrequent in neighboring places.

(3) Postglacial Valleys. Modern rivers often cut out much valuable coal. But they have been the means of forming numerous outcrops through the discovery of which the western coal field was first opened. They afford easy access to the coal which may be obtained by drifts or by shallow slopes. The narrow gorge of the

Des Moines river at the capital city is an excellent illustration of coal bearing strata cut through by modern erosive agencies. (Figure 22.) During the early settlement of the state for many years the districts presenting natural outcrops were the ones in which the coal industry was first established and carried on most extensively.

*Dislocations.*—The ruptures and slippings of the beds in the Iowa Coal Measures are comparatively unimportant. Geological "faults" are seldom more than a few feet in extent. The majority of these are of the normal variety with a hade of from 15 to 45 degrees. (Figure 23.) It would be impossible to recognize these slippings ordinarily except when fortunate artificial exca-

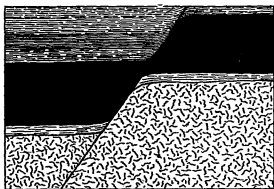


Figure 23. Fault. Bloomfield Shaft, Des Moines.

vations would disclose them. It is only through the extensive working of a comparatively thin bed that they are capable of being made out. The two faces of the fracture which have been rubbed together are

commonly very dense and highly polished and pass under the name of "slickensides." From an examination of the number and location of these small faults, and of others of similar character in distant regions, it would appear that the adjustment of the tension in the earth's crust here as in more mountainous regions is carried on largely by means of many small slips rather than a few large ones. Similar facts have been brought out in the mountain districts of

California, where recently Becker has made some interesting observations in this direction.

In a number of places step-faults have been observed. In the Davidson mine near Newton, in Jasper county, quite a number of slips of from six inches to four feet were noticed, the inclination being about 45 degrees. (Figure 24.) In the Deep Vein mine at Foster, in Monroe county, a similar series of step-faults has been made out. Instances of this kind are quite numerous in many parts of the state and in nearly all cases the different faults in any given series are practically parallel to one another. It has been noticed in some instances that when the line of

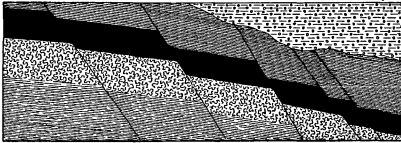


Figure 24. Step-fault. Davidson Mine, Newton, Jasper County.

slip passes from a hard to a soft layer or vice versa that it is changed in direction. In the first case the line of fracture is bent away from the perpendicular while in the latter it is bent toward the perpendicular in the same way as when light passes from a denser to a rarer medium. This is sometimes shown where a series of iron-stone nodules or a layer of iron-stone is enclosed in a coal seam.

Another phase of normal faults is shown where, in the crest of a small anticline, a wedge shaped piece is allowed to drop. A good illustration is found in the Appanoose mine at Cincinnati, in southern Appanoose county. (Figure 25.)

The term roll is applied to any part of the coal vein where the roof occupies a portion of the seam. In most cases it seems to be due to the pressure of the overlying rocks which squeeze out some or all of the softer bitu-

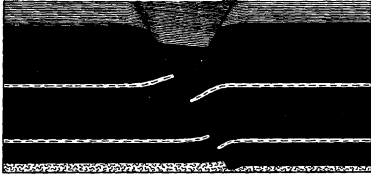


Figure 25. "Wedge" Fault. Appanoose Shaft, Cincinnati, Appanoose County.

minous layers. The rolls may be mere indentations of a few inches of the roof into the coal seam, as is seen in the Thistle mine, at Cincinnati, in Appanoose county; (figure 26) or, they may be found in connection with a slip fault as in Appanoose mine at the same place; or, it may

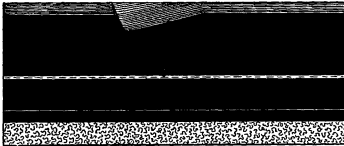


Figure 26. "Roll," Thistle Mine, Cincinnati.

occur at a fracture in a coal seam and accompanying beds where the coal vein has apparently parted a few inches allowing the roof to come down and the floor up; or, finally, the coal may be nearly or completely displaced, in



which case it is commonly called by the miners a "pinch-out." (Figure 27.)

*Clay Seams.*—Simple fissures or ruptures are not of unfrequent occurrence in coal veins. They are merely a separation of different parts of the coal seams without

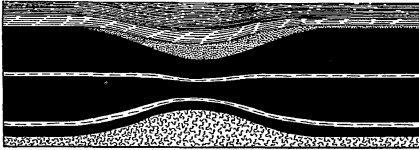


Figure 27. "Pinch." Mendota Mine, near south Line of Appanoose County.

displacement. They are usually more or less vertical with often very irregular borders; or they may be inclined at very considerable angles. Examples of the former are seen in the Reese mine at Panora, in Guthrie county, at the Christy mine near Des Moines, in Polk county (figure

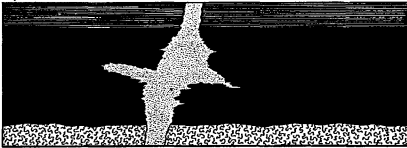


Figure 28. Fissure filled with Clay. Christy Mine, east of Des Moines.

28), at the Thistle mine at Cincinnati, Appanoose county, and elsewhere. The latter are met with in several places at the Keeler mine near Linden, in Dallas county. In the majority of cases clay fills the fissure which may be from

an inch to a foot or more in width ; or sand may occupy the space forming a compact sandstone wall.

There is another class of fractures which appear in the coal seams which are partly due to the forces producing faulting and partly to other causes, the most prominent of which, perhaps, is contraction. These are commonly called "joints". They are usually more or less vertical and form two sets running at right angles to one another. On account of their presence the coal is easily gotten in more or less cuboidal pieces. The adjoining parts are often separated by calcite, gypsum, iron pyrite or in some cases clay.

#### AVAILABILITY.

Profitable mining of coal has a number of restrictions imposed upon it in addition to those embraced under distribution. By far the most important of these natural obstacles to the economic working of a coal bed relates to the thickness of the seams.

*Insufficient Thickness.*—The limitation due to this factor varies greatly in different localities, not only in the country at large but within the boundaries of a single state ; and is dependent also on the presence of other limiting conditions even in the same county. In some districts, where veins of coal attain a vertical measurement of five to seven feet or more, a seam is rarely touched which has a thickness much below three feet. On the other hand, in districts where coal deposits are not very extensive a vein of two or even one and one-half feet is utilized. With the proper development of the industries connected with the manufacture of clay products it is very probable that the under clays and the overlying shales of coal beds will before long be taken out on a large scale along with the

coal. Brick especially, of all kinds, for which there is a constant and ever growing demand, comes prominently under this head. The shales above and below the seam are admirably adapted for making vitrified blocks of high grade for paving purposes, of unrivaled ornamental materials and the best of fire brick. Plants have already been erected in a number of places for the utilization of the refuse shales as they come from the mines, with good results. At Grand Junction, in Greene county, one brick company has sunk a shaft 150 feet for the clay found in connection with an eighteen inch vein of coal, the output of the latter being almost entirely used in the kilns. At Van Meter, in Dallas county, at Des Moines, Fort Dodge and elsewhere, large and well equipped works are in active operation the year round, manufacturing brick and tile from the shales near the coal seams. By removing the associated clays for the purposes named it is believed that the minimum thickness of a workable coal bed may be greatly reduced, perhaps as low as one foot in some cases. Veins which have long been allowed to pass unnoticed may thus be mined with profit. The combining of the two industries will doubtless lead in the near future to a very great development of both, for the uses to which clay is being put are many and are even increasing with astonishing rapidity. It may, therefore, be confidently expected that the minimum of adequate thickness of workable coal seams will become very greatly reduced and that the available amount of coal in the state will be doubled or trebled beyond what it is commonly thought to be at present. From the known form of the coal beds, disposed as they are in lenticular masses, it is not always safe to conclude after drilling a single hole through a "thin" seam that it is unavailable on account of

inadequate thickness. The bed may probably be thicker a shorter distance away in the direction of the center of the original basin; and yet it is quite possible that, on the other hand, it may rapidly thin out, and disappear.

*Depth.*—The second great factor in limiting the removal of coal with profit is that of excessive depth. In many mining localities this is a very serious restriction, but in Iowa it is relatively unimportant. The very large majority of the mines in the state have a depth of less than 150 feet; a number are from 200 to 250 feet deep; while in a very few instances the shafts go down as far as 300 feet. The mines in Missouri are very similiar to the Iowa pits in being comparatively shallow and according to Winslow the shafts rarely are deeper than 200 feet. The peçuliarities in the structure of the Coal Measures necessarily prevents deep mining along the eastern margin of the Iowa coal fields as far as, and even beyond the line of the Des Moines river. Westward from this limit, the best veins opened, gradually come to lie deeper and deeper. It is very probable that judicious deep drilling from 500 to 1,000 feet or more would reveal good coal in nearly all sections of the southwestern part of the state. For some reason or other deep prospecting for coal has as yet been undertaken only on a small scale. The significance of the suggestion is quite pertinent and has an important industrial bearing, especially in those southwestern counties which now mine little or no fuel. At Leavenworth, Kansas, a short distance from the boundary of Iowa, coal less than two feet in thickness is now being mined successfully in large quantities at a depth of nearly 800 feet. On the whole it is not at all probable that the factor of excessive depth will ever interfere seriously with the mining of Iowa coals.

In considering the depth at which coal may be profitably worked, it is interesting to refer to the facts as presented in other coal fields. In England veins little more than a foot in thickness have been mined at a depth of over 800 feet. It is not an uncommon thing in certain parts of the Lancashire district to find shafts from 1,200 to 2,000 feet deep, some even reaching a depth of 2,800 feet. In Belgium one of the Charlroi mines has been worked to a depth of over 2,400 feet. Nor is this regarded as the limit to which it is practicable to operate.

